Dr. Fletcher's Luncheon Talk at NSIA R&D Symposium
December 6, 1973

I would like, in my remarks today, to focus clearly on one particular aspect of the R&D challenge for the future. I would like to discuss with you the problems in adequate Federal Government support for basic research in the decades ahead.

As I see it, there is undoubtedly going to be a major upsurge in Government support of R&D over the next few years to help solve the Nation's energy problems. At the same time there are backlogs of important R&D programs needed for national defense, transportation, housing and urban affairs, environmental protection, and in every other sector of modern America. At NASA we have expanding programs in aeronautical R&D and for winning practical benefits from space.

So there are many new R&D programs and proposals on the national agenda, and I am sure the best of them will win strong support from the Administration and the Congress on their merits.

Public understanding of the potential returns from R&D programs has greatly increased in recent years, especially where practical benefits are concerned.

What worries me at this point is what is going to happen to basic research as we put increased emphasis on practical benefits and problem solving in the decades ahead.

I am directly concerned, of course, because an important part of the NASA space effort is basic research. That includes our Pioneer, Mariner and Viking programs to explore throughout the solar system, and our physics and astronomy programs conducted from Earth orbit. We are now emphasizing the practical benefits to be won from spacecraft in Earth orbit, especially when we have the Space Shuttle and the manned Spacelab module operating in the 1980s and 1990s. And we expect important developments in the new field of space manufacturing when the Shuttle and Spacelab are operational. (I might add that how important these developments turn out to be will depend in large part on the imagination and initiative which you R&D people from industry and your colleagues

show in exploring the unprecedented possibilities of space manufacturing and other commercial uses of the Shuttle and Spacelab.)

Despite our growing emphasis on practical returns from the space effort, we are strongly committed to exploring the planets and providing new opportunities for basic research in astronomy and physics.

So what can we do, in a practical sense?

I have a few suggestions:

One. We can make a special effort, and a continuing effort, to identify the critical areas where basic research and advanced technology (as contrasted with applied research and technology) or the development, i.e. the 6.1 or 6.2 funds of DOD and the astronomy and planetary exploration programs of NASA is required now to facilitate technological progress in the future. This is a responsibility that should be stressed in government and industry as well as in the universities. Since I am talking about practical steps, I am not going to lecture industry about doing more. But I can ask you to help us identify the most important areas

for public investment in advanced technology. And you can also help us justify these choices before the Congress and the public.

Two. We must combat the mistaken opinion in some quarters that when budget cuts have to be made, basic research is the most likely and most willing victim because advanced technology has no schedule that gives it urgency. We must popularize the idea that basic research has a need for continuity that is as important as a schedule dictated by current needs. Effective basic research requires that the institutions and people involved have a sense of security and continuity in their work.

Three. We can keep close tabs on what other leading industrial nations are doing in the way of basic research. I think we will see the European countries making a strong comeback in advanced technology. The European countries led in basic research and in most areas of new technology before World War II, and they have the capacity to do so again. And I think we will find that the Soviet Union is doing more in many important areas of basic research than most people realize.

Four. Effective long-range planning by agencies with large R&D programs will help those responsible for identifying the most likely areas for advanced technology. It is important that such long range plans be made public to the extent feasible. NASA has recently completed an important planning exercise describing hundreds of likely payloads between now and 1991 which could be flown without exceeding NASA's current annual budget. We have presented this planning document to the space committees of Congress, and it is also available to industry and university planners.

Five. We can make a concerted and continuing effort to cut the costs of advanced technology, especially where complex new instruments and other technological support is required. NASA is making a successful effort to reduce the costs of building and maintaining spacecraft. Our plans for using the Shuttle and the manned Spacelab module will also reduce the costs of building and flying experiments, and reduce lead times and risks as well. This greatly enhances the opportunities university scientists will have to participate in the space program.

Six. We must take whatever steps are necessary to wipe out the boom-or-bust approach to advanced technology.

We have done that in the economic field. Until the Great Depression of the Thirties, people in this country thought they had to put up with periodic economic cycles that led from runaway inflation to deep depression to runaway inflation again.

In the past 40 years we have taken many steps to prevent economic cycles from running to such extremes. The Federal Reserve system regulates the money supply with some precision, bank deposits are insured, the stock markets are regulated, farm prices are supported, and so forth.

I believe we should show similar good sense in devising policies and programs to avoid chronic scientific depressions.

There are bound to be some ups and downs in research activities as national priorities change and new opportunities open up. But we can do a lot better than we have been doing to set and maintain steady budgets for basic research

with long-range goals. And by steady budgets I mean budgets that rise somewhat as the Gross National Product of the country rises, but that don't necessarily fall so much when the GNP takes a temporary down turn.

Seven. NASA and others can plan and conduct their basic research programs in such a way as to give maximum support to university science and engineering research in general and graduate education and post-doctoral education in particular. We try to do this now -- albeit highly unsuccessfully. We must continue to keep this in mind.

Eight. The importance of advanced technology must be made understandable for the public.

Nine. We must all work to overcome the antipathy and indeed hostility that has grown up in university communities against science and technology.

Some of the reasons for this negative attitude have been:

a) The war in Viet Nam seemed to many on campus an example of the misuse of American science and technology, and this generated hostility for the campus-based research sponsored by the Department

of Defense and other agencies.

b) Rising concern for the environment focused to a considerable extent on the pollution caused or threatened by modern industry.

c) Some persons in the academic world became jealous of the Federal Government support for scientific research being given to other scientific and engineering departments and disciplines of their own university. Agitation developed for greater Federal funding for the social sciences and the humanities, and science and technology were disparaged.

These factors causing hostility to science and technology on campus naturally had an impact on the number of students choosing careers in science and engineering. This trend, if continued, could weaken our country for many years to come. There is now some evidence, however, that this trend has been reversed, and more students are preparing for careers in science and engineering.

The general public does not foresee the long-range harm of cutting back on advanced technology and turning able students away from careers in R&D science and engineering. But we who work in the R&D field know that we will pay dearly in the long run for our false economies and careless attitudes today. It is up to us to get this message across to the budget makers and the Congress.

We must also make clear the career opportunities in science and engineering. If we don't do some of these things, it is almost certain that 10 years from now there will be a serious shortage of scientists and engineers in this country. And when another crisis like Sputnik breaks over us, we will not have the highly trained scientists and engineers we need to react promptly. How do I know there will be another such crisis? Well, we practically guarantee there will be such a crisis when we lay off thousands of engineers from industry and there are no job opportunities for the new young scientists and engineers, many of whom have their doctorate.

If we ignore basic research at this time when we seem overwhelmed by "practical" roblems, it is likely that 20 years from now we will find that our economy has stopped growing as it should because of a lack of new ideas and new products and new technologies which should have resulted from basic research in this decade.

And 50 years from now, if we do not stress basic research and scientific excellence in the meanwhile, we will see the grim predictions of the Club of Rome beginning to come true. We will find our modern technological society breaking down and the crowded billions on this Earth facing disaster. And it will then be too late to stop the downward spiral to destruction.

Actually, I don't believe this prediction of disaster in 50 years will ever come true. Because in the meanwhile, there will be a series of smaller crises and we will in good American fashion react to them with great energy and huge sums of money and we will pull ourselves through, like we did with Apollo in the Sixties after the complacency of the Fifties.

The prediction I would really like to make -- but as of now I can only express the hope -- is that we will take the necessary steps to wipe out boom-and-bust cycles in basic research and science. Beginning now.

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I would like, in my remarks today, to focus clearly on one particular aspect of the R&D challenge for the future. I would like to discuss with you what we might do to obtain and maintain adequate Federal Government support for basic research in the decades ahead.

I know I don't need to convince you of the value of basic research to support the cutting edge of American technology in a highly competitive world. But there are some important changes coming in the R&D picture, as your sessions have no doubt brought out; and I think the country probably needs your special attention and help to make sure basic research doesn't get lost in the shuffle, or left on the cutting room floor.

As I see it, there is undoubtedly going to be a major upsurge in Government support of R&D over the next few years to help solve the Nation's energy problems. At the same time there are backlogs of important R&D programs needed for national defense, transportation, housing and urban affairs, environmental protection, and in every other sector of modern America. At NASA we have expanding programs in aeronautical R&D and for winning practical benefits from space.

So there are many new R&D programs and proposals on the national agenda, and I am sure the best of them will win strong support from the Administration and the Congress on their merits.

Public understanding of the potential returns from R&D programs has greatly increased in recent years, especially where practical benefits are concerned.

What worries me at this point is what is going to happen to basic research as we put increased emphasis on practical benefits and problem solving in the decades ahead.

I am directly concerned, of course, because an important part of the NASA space effort is basic research. That includes our Pioneer, Mariner and Viking programs to explore throughout the solar system, and our physics and astronomy programs conducted from Earth orbit. We are now emphasizing the practical benefits to be won from spacecraft in Earth orbit, especially when we have the Space Shuttle and the manned Spacelab module operating in the 1980s and 1990s. And we expect important developments in the new field of space manufacturing when the Shuttle and Spacelab are operational. (I might add that how important these developments turn out to be will depend in large part on the imagination and initiative which you R&D people from industry and your colleagues show in exploring the unprecedented possibilities of space manufacturing and other commercial uses of the Shuttle and Spacelab.)

Despite our growing emphasis on practical returns from the space effort, we are strongly committed to exploring the planets and providing new opportunities for basic research in astronomy and physics.

My interest in strong support for basic research goes far beyond my connection with the space program, however. I have also learned to appreciate the value of basic research as a working scientist, as a businessman in defense-oriented electronics, and in six years at the University of Utah. I know its potential and its problems. I want to win continued understanding and support for it in every way I can. I want to see the Science and Technology Base programs of the National Science Foundation strengthened in addition to the very worthwhile current emphasis on RANN programs -- that is, the Research Applied to National Needs programs. I would also hope that the Atomic Energy Commission can continue strong support of basic research in physics even while it helps solve today's energy crisis. And I am sure there will continue to be certain specialized areas of basic research of particular interest to the Department of Defense. And so on.

So what can we do, in a practical sense?

I have nine suggestions:

One. We can make a special effort, and a continuing effort, to identify the critical areas where basic research is required now to facilitate technological progress in the future. This is a responsibility that should be stressed in government and industry as well as in the universities. Since I am talking about practical steps, I am not going to lecture industry about doing more basic research. But I can ask you to help us identify the most important areas for public investment in basic research. And you can also help us justify these choices before the Congress and the public.

Two. We must combat the mistaken opinion in some quarters that when budget cuts have to be made, basic research is the most likely and most willing victim because basic research has no schedule that gives it urgency. We must popularize the idea that basic research has a need for continuity that is as important as a schedule dictated by current needs. Effective basic research requires that the institutions and people involved have a sense of security and continuity in their work.

Three. We can keep close tabs on what other leading industrial nations are doing in the way of basic research. I think we will see the European countries making a strong comeback in basic research. The European countries led in basic research before World War II, and they have the capacity to do so again. And I think we will find that the Soviet Union is doing more in many important areas of basic research than you might think.

Four. Effective long-range planning by agencies with large R&D programs will help those responsible for identifying the most likely areas for basic research. It is important that such long range plans be made public to the extent feasible. NASA has recently completed an important planning exercise describing hundreds of likely payloads between now and 1991 which could be flown without exceeding NASA's current annual budget. We have presented this planning document to the space committees of Congress, and it is also available to industry and university planners.

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We must also make clear the career opportunities in science and engineering. If we do not, I predict that 10 years from now there will be a serious shortage of scientists and engineers in this country. And when another crisis like Sputnik breaks over us, we will not have the highly trained scientists and engineers we need to react promptly. How

do I know there will be another such crisis? Well, we practically guarantee there will be such a crisis when we cut back on basic research and fall behind in training and employing excellent scientists and engineers.

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